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HISTORY AND GEOGRAPHY OF PLAGUE IN CHINA

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## HISTORY AND GEOGRAPHY OF PLAGUE IN CHINA

[Following is the translation of an article by V. A. Kraminskij in the Russian-language journal Izvestiya Irkutskogo Gosudarstvennogo Nauchno-Issledovatel'skogo protivochum-nogo instituta Sibiri i Dal'nego Vostoka (News of the Irkutsk State Scientific Research Anti-plague Institute of Siberia and the Far East), Vol 25, 1963, pages 254-272.]

Affliction of man by the plague has been known in China since ancient times under the name of "Wen-i," "I-ch'-eng," "Shu-i," and other names. In 610 A. D. Chao Yuang-fang in his work P'ing Yuan ("Origin of Disease") wrote on the disease "Yeh he" (Malignant Bubo), "The disease develops suddenly, is accompanied by high fever and the appearance of nodules under the skin. The nodules vary from bean-size to plum-size. Skin and muscles around these formations are dry and painful. If measures are not quickly taken, the poison will enter the organism, induce severe shivering, and lead to death" (cited by Wu Lien-teh, 1936). Another well-known physician of the same epoch Sung Ts'u-mo (died in 625 A.D.) in his book Ch'ien ching fang ("Valuable Counsel") reports that the "malignant bubo" disease was common over the territory of the then Kwang tung province, but had been infrequently observed in the interior provinces (cited by Wu Liang-te in the previously cited reference). A thousand years later, Wu Yu-i in his Treatise on Epidemics (Wei Ying-lung, 1912) reported on a disease which he called "k'uo t'a weng," which means "bubonic epidemic." The disease is characterized by the appearance of "tumors" (buboës) in different parts of the body, spreading rapidly and widely in several cases resulting in the death of those affected several hours after the first symptoms of the disease appear.

In the 1726 edition in Peking of Imperial Encyclopedia (K'ang Heng) a list of 234 of the greatest epidemics is given (plagues -- "i ch'eng"), occurring in China beginning from 224 A.D. to the time of publication.

Wang and Wu Liang-te in their History of Chinese Medicine (1936) point out that some of the plague-like epidemics ("i-ch'eng") mentioned in the ancient sources, especially those related to wars, mass hunger, floods, etc., were more probably epidemics of parasitic typhus, which has been accompanied by national calamities since ancient times in Chinese history. On the other hand, these authors regard some of the epidemics as definitely plague, since they either coincide in time of origin with established plague pandemics, or the descriptions of these epidemics in the ancient sources contained indications as to the symptoms of the disease which are clinically similar to bubonic or pulmonary plague. Thus, Mishu (cited in Nikitin, 1947) presents a report of one missionary, reading in the travel diaries of Jesuits sent to the Chinese emperor in 1617 to explore Yunnan province, "a description of disease wholly similar to yang-chieh-ch'ing (bubonic plague) of our time."

Wu liang-te particularly emphasized one report in his manuscript as referring closely to an epidemic of plague: "in 1644, a Great plague in Lu-an (the modern province of Shansi). Hard formations on the neck or shoulder (under the skin), resembling blood clots were observed in the victims. Whole families died. In several cases the diseased suddenly spat up blood and expired."

In studying the list of plague like epidemics the fact is noteworthy that several regions of the country are often affected by epidemics, unrelated to floods, drought, locust invasions, famine, while other parts of the country very rarely suffered from epidemics, which usually coincide with elemental disasters. For example, in the province of Honan [given as Henan] extensive plague-like epidemics occurred in the following years: 125, 151, 161 '71, 179, 185, 217, 223, 234, 235, 242, 274, 275, 276 and 292 A.D. It can be assumed that in this period the territory of the Honan Province was a natural plague focus, constituting a continuation of the not-long-expired plague of the neighboring provinces of the Shansi and Shensi (last epidemic in 1942). Later, as the land was adapted to farming, leading to a reduction in the enzootic territory, plague epidemics in Honan became much less frequent: 468 (simultaneously over all of China), 565, 636, 658, 682, and 707 A.D. As the manuscript

notes, some of the epidemics were related to the invasion of plague from Shansi (642, 643, 644, and 648 A.D.). The last extensive plague after 707 A.D. in Honan occurred only in March of 1127 A.D. "When the forces of Ch'ing lay seige to Pieng-Ping (now Kaifeng) plague broke out, which carried away almost half of the inhabitants." The next great epidemic affected Honan in April 1233. "During 50 days," reports a manuscript, "90,000 corpses were carried through the city gates of Kaifeng, not counting the very poor, who could not be laid in individual graves." The epidemic striking Honan in the spring of 1356 evidently was related to the global pandemic of plague in the 14th century. The last plague-like epidemic in Honan, in 1544, coincided with an epidemic in Shansi (1543-1544).

Of 32 epidemics occurring in the territory of the Honan province over 1400 years, only one is related by manuscripts to drought (1588) and one (1127) to war.

In contrast, most of the many epidemics occurring during this same period in more populated provinces are related, according to the manuscripts, to hunger, drought, migrations, etc.

The more ancient agricultural assimilation of territory, the development of trade and means of communication, and also the high population density suggest that the principal role in pestilential diseases here is not played by plague, but rather by parasitic typhus.

In 1792 in the city of Chao-chou (Yunnan) as reported by Hua Hung-liang-hi (cited by Wu Liang-Te) "there began to appear in the houses in the daytime strange rats, that succumbed there from hemorrhaging. There was not a person who could avoid sudden death having been affected by the mismas (of these rats)." Shih Tai-nan, known for his poetic gifts, composed a poem, a section of which, headed "Rat Death," very graphically depicts this disaster:

Dead rats on the east,  
Dead rats on the west!  
Dear rats are more fiercesome than tigers.  
After several days  
After the death of the rats -- corpses litter  
the steppe.  
Countless dead by day!  
In their fear people no longer notice the sun.

If three persons work together  
Two of them fall dead  
At a distance of ten paces.  
Numberless dead by night!  
No one dares to mourn the dead.  
After a visit of the demon plague  
Lamps suddenly flicker out,  
Leaving the soul and body in darkness.  
The crows croak endlessly,  
Mournfully howl the dogs.  
Man and spirit are one,  
when the soul has left the body.  
The earth is covered with human bones,  
In the field are left ungathered harvests.

Even the landlords do not collect taxes.  
I wish to leave on the red dragon,  
In order to meet with the Gods in the heavens  
And ask them to send a heavenly moisture  
And again revive the dead.

Soon after completing this poem, the author succumbed from plague.

The data presented above demonstrates the ancient existence of plague in China. Wu Liang-Te (1936) nonetheless believes that in the last two to two and a half centuries, the dissemination of plague in China has occurred as a result of the incursion of this infection from without by maritime (Hong Kong, Shanghai) and overland (Yunnan) trade routes, and not due to the existence of natural foci within the country.

Study of the history of the spread of plague in China in recent times (19th-20th centuries) only partially supports the validity of this view, and does so only with respect to the coastal area of the country.

Recording of plague outbreaks in China began after suppression of the Taip'ing Revolution (1865). The number of patients and fatalities was not always counted (Tables 1 and 2).

Table 1

Plague in China During 1966-1937 (according  
to Wu Liang-te 1936)

Year	Affected Cities and Provinces
1866	Yunnan-fu (Kunming)
1867	Pakhoi
1871	Yunnan Province, Pakhoi
1877	Pakhoi
1880	Liench'eng
1882	Pakhoi and neighboring hsien
1883	Lanchow (Kansu)
1884	Pakhoi
1889	Lungchow
1890	Lungchow, Wuhu
1891	Liench'eng, Lungchow, Kaochow
1892	near Anku
1893	Yunnan and Kwangsi Province, Lungchow
1894	major epidemic in Canton and Hong Kong
1895	Canton, Hong Kong, Macau, Mentse (tz'u), Pakhoi, Island of Hainan, Swatow, Amoy
1898	Canton, Hong Kong, Macau, Samisui, Hinghua, Swatow, Yuchou
1899	Pakhoi, Hong Kong, Swatow, Foochow, Inkou
1900	Pakhoi, Hong Kong, Island of Hainan, Foochow, Swatow, and other cities of Fukien province
1901	Mentse, Luchou, Pakhoi, Weichow, Hong Kong, Macau, Samisui, Swatow, Foochow, Lunyang, other cities of Fukien Province.
1902	Pakhoi, Hong Kong, Canton; Swatow, Changpu, and other cities of Fukien Province
1903	Hong Kong, Canton, Swatow, Amoy, Foochow, Peitan
1904	Hong Kong, Swatow, other cities of Fukien Province.
1905	Hong Kong; Yuanchung, other cities of Fuk- ien Province
1906	Hong Kong, Canton
1907	Hong Kong, Macau, Tikong
1908	Hong Kong, Amoy, Shanghai (plague epizootia among rats)
1909	Nampo, Canton, Hong Kong, Amoy, Swatow, Han- kow Shanghai (among rats); Lunyang and other cities of Fukien Province

1910	Pakhoi, Lungchow, Island of Hainan, Canton, Hong Kong, Swatow, Amoy, Shanghai. The leading plague epidemic was in Manchuria (100,000 cases)
1911	End of plague epidemic in Manchuria. Pakhoi, Hong Kong: Swatow, Chaoyang, Chaochow and other cities of Fukien Province; Amoy, Shanghai
1912	Pakhoi, Island of Hainan, Canton, Hong Kong, Macau, Swatow, Amoy, Shanghai, Yuanting, and Shanghang (Fukien)
1913	Pakhoi, Hong Kong, Swatow, Canton; Amoy, Shanghai, Tunghai and other cities of Fukien Province
1914	Pakhoi, Hong Kong, Canton; Foochow, Swanghang, and other cities of Fukien Province; Swatow, Amoy, Shanghai
1915	Pakhoi, Hong Kong, Swatow, Yungchun, Shanghai (one case); Fukien Province
1916	Hong Kong, Canton, Chaochow, Amoy, Lunyang (Fukien Province)
1917	Hong Kong, Amoy, beginning of major epidemic in Shangsi province; Fukien Province
1918	Hong Kong, Shansi Province, Fukien Province
1919	Hong Kong, Fukien Province
1920	Hong Kong, major epidemic of pulmonary plague in Manchuria (beginning), Fukien Province
1921	Hong Kong, pulmonary plague epidemic in Manchuria (conclusion), Fukien Province
1922	Hong Kong, Fukien Province
1923	Canton, Pengping, Hong Kong, Fukien Province
1924	Shanghai, Fukien Province
1925	Pakhoi
1926	Fukien Province
1927	Fukien Province
1928	Hong Kong (four cases), Shansi Province, Tungliao region, Fukien Province
1929	Hinghua, and other cities of Fukien Province, Tungliao Region
1930	Tungliao Region, Fukien Province
1931	Amoy, and other cities of Fukien Province, major epidemic of bubonic plague in the provinces of Shensi, Shansi, and Szechwan (20,000 deaths)
1933	Tungliao region, Fukien Province
1934	Kuanchow Wan, Tungliao Region, Fukien Province
1935	Amoy, Foochow, Swatow, Kuanchow Wang, Manchuria (Tungliao region), city of Lunyang.

1936  
1937

Sunghang, and other cities in Fukien Province  
Kuanchow Wang, Manchuria, Sunghang  
Manchuria, Fukien Province, Island of Hainan

We must note the general tendency of several epidemiologists of the Kuomintang period to represent plague as an exclusively invasive disease, appearing in China only in the 19th century. Wu liang-te (1920, 1936, etc.), wholly ignoring the existence of natural enzootic plague foci in Manchuria, Inner Mongolia, Shensi and Shansi, explains almost all outbreaks and entire epidemics of plague in the north by invasion.

Wu Kiang-te and several other Chinese and foreign specialists, advocates of the theory of plague invasion from without, were members of the National Quarantine Service, maintained by the Board of Chinese Tariffs (from 1863 to 1948 -- under British control). Recognition of plague as an infection endemic to China, and admission of the existence within the country of several natural foci threatened Chinese brokers and customs masters (the British) with serious losses, since restrictions on export trade and navigation would have to be imposed. It was much more convenient to regard plague as invasive and be limited to relatively inexpensive measures of examining arriving ships and ridding them of rats. At present, this view has been completely refuted by epidemiologists of the Chinese People's Republic (Cheng Weng-guey, Yang Ch'ing-hsiu, Ch'u Fang-choi, 1960).

However, the incursion of plague into China from countries of Southeast Asia (India, Burma, Indonesia, Laos) in the past doubtless did take place. This was made easier by the poor organization of quarantine measures and by the infestation of all ships by rats in the 19th and during the first quarter of the 20th century. Ships sent to China from plague-troubled ports of the Indian Ocean, Sea of Japan, and South China Seas, often carried on board persons ill with the plague, and infected rats.

The maritime approach became especially important for penetration of plague in China after the "opium war" and the opening of a large number of ocean and river ports for trade (1842 -- Shanghai, Ningpo, Amoy, Foochow, Canton; 1958 -- Nangking, Tsankong [Chankiang], Chisu, Swatow, Chiu-chiang, Hangkow, Yingkow, Wenchow; 1860 -- Tientsin; 1876 -- Wuhu, Pakhoi, Ichang; 1886 -- Kowloon; 1890 -- Chinch'ing, etc.).

**Table 2**  
**Morbidity of Plague, Mortality, and Number of Affected Hsien**  
**[a unit of territorial subdivision] in China by Years**

		1940	1941	1942	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952	1953
(2) Провинции															
Чжэцзян (6)		121 (3) 116	355 (3) 319	95 (4) 12 (8)	673 501 (9)	841 115 (4)	318 239 (6)	686 90	228 26	38 4	58 4	—	—	—	—
Фуцзянь (7)		145 (3) 64 (14)	626 (16) 335	135 (23) 57	4764 (35) 384	465 (29) 102 (31)	1655 (42) 415	717 (24) 24 (32)	1418 280	608 217	1417 119	29 (2) 58	—	—	—
О. Тайвань (8)		—	—	—	—	—	—	—	—	—	—	—	—	—	—
Цзянси (9)		—	—	37 (1) 31	30 (2) 25	42 (1) 29	108 (2) 244	171 (1) 61	815 (6) 327	363 161	70 32	8 1	—	—	—
Гуандун (10)		22 (7)	85 71	23 (2) 8	7 (2) 1	136 (5) 87	27 (1) 10	823 (7) 355	176 (1) 106 (1)	110 106	... 3	61 25	5	—	—
Юньнань (11)		199 (11) 96 (1)	—	—	—	542 (4) 27 (4)	43 (4) 14	628 (7) 158 (7)	712 (6) 231	118 35	891 35	142 123	21 174	163 106	41 4
Хунань (12)		—	—	7 62 (1)	92 (1) 62 (1)	3 (1) 0 (1)	—	—	—	—	—	—	—	—	—
Северо-западная об- ласть, Шаньси, Шэн- си, Нинся, Суйюнь . .	(f)	39 (1) 33 (1)	674 (1) 601 (1)	—	—	—	—	—	—	—	—	—	—	—	—
Северо-восточная об- ласть (Мальчжуния) .	(j)	2551 2019	704 — 550	873 651	1958 1287	150 1493	4557 2557	3026 2311	597 159	446 272	316 159	310 150	95 3	1263 154	81
АО Внутренняя Мон- голия . . . . .	(k)	—	—	—	—	—	—	—	—	—	—	—	—	—	—

① Вместе с Северо-Восточными Китаем

[Legend: ] a) province; b) Island  
of Taiwan; c) Fukien; d) Island  
of Kiangsi; e) Kwangtung; f) Honan;  
g) Yunnan; h) Suyuan; i) Tungpei [Ne  
i) northwest region, Shansi, Ninghsia,  
Region] (Manchuria); k) Inner Mongolian Autonomous Region; l)  
together with Northeast China. [Remarks on next page]

Remarks: Numerator denotes morbidity, denominator -- mortality, ( ) -- number of hsien affected by plague, .... no data available.

The first South China port, where plague could have been brought in from ports of Indochina and elsewhere, was Pakhoi (province of Kwangtung). Reports of plague in Pakhoi points to its appearance there in 1867 and then to yearly outbreaks of a greater or lesser extent right up to 1925 (Wu Liang-te 1936). The largest outbreaks were in 1871, 1882 (up to 5000 dead), 1884 (more than 500 dead).

It is, however, difficult to know for certain that plague in Pakhoi and the adjoining regions was related only to invasion by sea. Wu Liang-te presents such a report of one Catholic missionary: "Bubonic plague is endemic in a small focus near An-pu (in a mountainous area, 160 kilometers east of Pakhoi. At any time of the year isolated cases can be observed there. During several years plague epidemic break out there in early spring, and the only way to avoid death is to leave the area and not return until heavy rains come (July-August)."

In Canton, plague was evidently brought in by the sea in January, 1894 and reached its maximum by May. The number of persons perishing from this epidemic totaled 70,000, and according to some reports, 100,000. Later, plague outbreaks were almost annual in Canton up to 1916. Then, outbreaks were noted only in 1923 and 1925, after which morbidity was sporadic in nature for some time, and in recent decades has disappeared altogether.

Hong Kong has long been the site of annual plague outbreaks, both human and rat. It is possible that plague has often been brought in to Hong Kong from without, and then maintained for a more or less extended period in rats, from which it was transmitted to persons. In spite of the abundance of rats in Hong Kong, plague has not been decisively acclimatized there and has not established a permanent focus (the last case was in 1928). Periodic entry of plague-infected rats by sea to several other ports of China (Dal'niy, Ying-kow, Tientsin, Shanghai, Ningpo; Hanchow, Amoy, Swatow, Canton, Foochow, Pakhoi etc.) have also not led to the formation in one of the ports of a persistent plague focus.

In the province of Kwangtung, plague continued to rage fiercely considerably longer (the last recorded plague

epidemic was in 1952), sometimes resulting in port outbreaks, the origin of which could be easily traced to the maritime mode of entry. In addition to this type, outbreaks were noted there in regions removed from the ocean and along a large route of transport (river, railway, highways). These outbreaks are customarily explained by the entry of plague by "disembarked rats" (Jettmar 1947).

We have not available to us any definite data pointing to the existence of natural plague foci in the province of Kwangtung. However, almost annual plague occurrences (Tables 1 and 2), often beginning in spring in regions removed from the ocean and other means of communication, force a re-examination of the existence of these foci.

Fauna of Kwangtung rodents has been little studied. In addition to house mice and several species of rats (Abe, 1940) has noted the existence there of two species of bamboo rat (Rhysomys sinensis and R. Pruinosis), flying squirrels (Petaurista petaurista rutines), and the southern grinn squirrel (Dremomys rufifrons melli and Dremomys pyrrhomerus).

Of the fleas that are the most active plague vectors, in Kwangtung Province the Xenops cheopis and Leptopsyllaya segnis, found almost everywhere in China, have been noted. Both these species are found here to be often spontaneously plague-infected (Cheng Weng-kuei, Yang Ch'in-hsiu, Ku Fang-chow, 1960).

The island of Hainan is believed to be a focus of rat-borne plague (Jettmar, 1948). Human affection begins in spring (April, March), which can point to the autochthonous character of the outbreaks.

It is known (Abe, 1940) that on the Island of Hainan are found the ground squirrel (Dremomys rufifrons), four species of rats (Rattus rattus hainanicus, R. nitidus, R. losea exignus, R. conficianus), the house mouse (Mus bactrianus kakhyensis), hare (Lepus Hainanicus), chipmunk (Tamias sivinhuelli hainanicus), flying squirrel (Pteromys electilis, Petaurista), the forest squirrel (Callosciurus erythraeus, known to be plague carriers, and the giant squirrel (Ratufa gigantea hainana)). In recent years data on human plague morbidity is lacking for the Island of Hainan.

Jettmar (1947) believes that all of the southeastern coastal area (the Provinces of Kwangtung, Fukien, the Island of Hainan) encompassed by a permanent plague-unfavorable incursion from the Central Asiatic focus through the province

of Yunnan. If we take into account the difficulty and slowness of reports, the remoteness of this focus, the scarcity of population in the mountainous regions of the provinces of Sinkiang and Yunnan, the opinion of Jettmar can scarcely be held valid.

The province of Szechwan until recent times has been annually affected by plague (cf Table 2). In the last decade, there have been no instances of plague reported among the population.

In addition to port plague (Ningpo, Wenchow, Hanchow), in the province of Chekiang plague outbreaks have frequently developed at considerable distance from the ocean, unrelated in time to occurrences in the port cities. Thus, during 1946-1947, in addition to sizable outbreaks in the region of Wenchow (329 in 1946 and 116 in 1947) outbreaks were noted in the cities of Taishun, Pingyuan, Yunhe, at a distance from railroads and water routes. Earlier, outbreaks of plague had also been noted in these areas of the province of Chekiang adjoining the endemic region of the province of Fukien and the mountainous region of the province of Kiangsi, where plague evidently was also endemic.

In the province of Chekiang, in addition to house mice (*Mus bactrianus* and rats (*R. norvegicus* and *R. rattus*), we find that the Chinese rat (*R. confucianus*), the field mouse (*Apodemus agrarius ningpoensis*), the vole (*Eothenomus melanogaster*), the southern ground squirrel (*Dremomys pernyi calidior*), and also the forest squirrel (*Callosciurus erythraeus ningpoensis*, and *C.e. styani*) (Abe, 1940). The latter is a plague carrier in the province of Yunnan.

The Fukien Province is one of the most ancient plague areas in China. In the record of plague-like epidemics ("i-cheng") this province is repeatedly mentioned: in the years 790, 840, 1344, 1369, 1435, 1480, 1486, 1535, 1545, 1556, 1562 (70% of the total population perished), 1609, 1613, and 1617, where indications as to any relationship with hunger, war, drought, etc., are usually lacking.

The latest history of the plague in Fukien officially begins from 1894. Since this time, plague outbreaks here have continually recurred, encompassing not so much port cities as much as inland mountainous areas with a weakly developed network of paved roads and lacking railroad lines. Nonetheless, Wu Liang-te (1936) regards the outbreaks of plague in the innermost regions of the province of Fukien as

the result of its incursion from ports along river routes or overland, or by unpaved roads.

Outbreaks of plague have been noted in the port of Foochow in 1894, 1901, 1902, and 1914. In 1946 there were 1,417 cases. A major plague epidemic occurred in 1931 in Chan-chow and Shi-ma (1600-1700 cases). A limited outbreak occurred in 1933 in Tunan (near Amoy).

Plague also appeared in Swatow in 1894 and reappeared almost annually as outbreaks until 1916, after which only sporadic cases were noted.

A similar situation prevailed in the port of Amoy, where outbreaks of plague were recorded in 1894 and 1901, and from 1902 to 1917 -- annually.

During the last decade, plague has been recorded in Fukien in 1950 -- 1447 cases, 1951 -- 299, and 1952 -- 284. Since 1953, no plague has been noted among persons in Fukien, and epizootics have occurred much less frequently.

Yang, Landauer, Koo, and Lin (1939) studying the epidemiology and epizootiology of plague in foci of the province of Fukien (Lung-yen, Shunkiang, Sunch'i, Chenhe, and Nanp'ing) noted that here subspecies of the black rat are generally found in the houses (Rattus rattus alexandrinus and R. R. rattus), and in the outdoor structures and basements -- R. norvegicus; in addition, the polycuspid shrews often run at night into residences (Suncus murinus).

Pollitzer (1948) believes that rats which are encountered here in as many as ten different species and subspecies, are the most important epizootic factor. He attributes considerable importance to the polycuspid shrews, which often are hosts of the flea Xenopsylla cheopis (probably, due to exchange of ectoparasites with rats). Spontaneous infection of these shrews with plague bacilli has been established. The importance of house mice, which here can also found plague-infected, is held to be limited by Pollitzer, since mouse fleas as a rule do not seek man.

Also found among rodents in Fukien is the forest squirrel (Callosciurus erythraeus) found to be plague-infected in Yunnan, and the ground squirrel (D. remomys perni), whose importance in plague epizootiology has yet to be studied. In addition, here we find the yellow-chested rat (R. flavitectus), the Chinese rat (R. confucianus), the Anderson rat (R. andersoni), the giant rat (R. bowerasi), the

field rat (R. Losea), bamboo rats (Rhyzomys genus), harvest mice (Mikromys genus), field and forest mice (Apodemus genus).

A large number of rabbits are maintained by the population (Oryctolagus sp.), where in several hsien extensive plague epizooties occurring simultaneously with epidemics among the population and epizootias in wild and synantropic rodents were observed in 1950.

Recent investigations made during 1954-1957 in the province of Fukien by the Antiplague Organization of the Chinese People's Republic have shown that in fields and in mountains near villages there are locations for the most frequent trapping of field rats (R. Losea), house mice (Mus musculus bactrianus) and the polycuspid shrews (Suncus murinus), and that gray and black rats are infrequently found in fields. Infected gray and black rats, house mice, and shrews have been found. The following species of fleas in Fukien have been found to be infected: X. cheopis, representing here 37.8% of all fleas collected with rodents, Leptopsylla segnis (52% of catches), Ceratophyllus (Monopsyllus) anisus (6.1% of catches), C. (Nosopsyllus) nicanus (3.8% of catches).

Plague among humans is found in Fukien the year around. In the south of the province, where a warm maritime climate prevails, morbidity begins to increase during March-April, reaches a maximum in May-June, and drops off in July-August, accounting for only individual cases from September to March. In the north of Fukien, plague evidences the first initial increase in April, then decreases, and accounts for a second, large rise during August-November.

The bubonic form of plague predominates in Fukien (94.6%). Pulmonary (primary and secondary, together) represent 3.9% of the cases and are observed chiefly in the northern hsien with their continental climate.

It is difficult to imagine how plague, absent for definite periods in ports, can be transferred across unpaved roads to small mountain cities and villages. Jettmar (1947) regards plague in the Fukien Province to be autochthonous, without substantiation. In the plague museum in the city of Yunan (200 kilometers from the sea) he was shown the stuffed carcass of a marmot (species not determined) and reported that these animals often attack peasants in the surrounding mountains. This fact supports the view of Jettmar that in this area, plague is dependent for its existence on wild

rodents, as infection reservoirs. "However, at present," writes Jettmar, nevertheless, "only rats play a decisive role in the distribution of plague in Fukien." The question as to infection reservoirs in the province of Fukien can be solved only by careful investigation of plague epizootology here.

On the Island of Taiwan (Formosa) plague was permanently endemic at the close of the last and the beginning of the present century. Outbreaks were strongly seasonal, beginning annually in May. The number of plague cases among the population was very substantial.

Presently, it is difficult to say whether Taiwan is a natural plague focus, or whether plague here has become temporarily acclimatized to synantropic rodents. Studies on plague of wild rodents, the fauna of which is very rich on Taiwan but little studied, are very few. This island contains (Tate, 1947) numerous representatives of gray and black rats (*Rattus* genus), sheet-toothed rats (*Bandicota* -- *Nesokcia*) ground squirrels (*Dremomys*), house mice (*Mus*), field and forest mice (*Apodemus*), forest squirrels (*Callosciurus*), flying squirrels (*Petaurista*), and others. Major epidemics of plague have not occurred in Shanghai. Limited outbreaks, in spite of the numerous rats in the city and in the port, soon expire, without producing any long-lived focus, as has occurred in Hong Kong.

Sporadic cases of plague have also occurred in several other ports of China (Wenchow, Hanchow, Ningpo, Tientsin, Dal'niy, Yingkow, etc.). At the beginning of this century temporary plague foci became appreciably developed in the city of Yingkow as a permanent rat focus. It must be assumed that the incidence of plague outbreaks in Yingkow depended above all on the incursion of plague from the nearby South Manchurian focus.

In addition to maritime and river routes, plague can be brought into China both by overland roads joining it to Burma, Vietnam, and Laos.

Plague can penetrate from endemic foci of southern Asia into the province of Yunnan, which is perennially affected by this infection. Some hold the view that Yunnan has its own plague foci (Kladnitskiy, Skorodumov, Gromashevskiy, Fenyuk, Chao Yu-ling, etc.). This belief is founded on the above cited reports of Mish, Huang Hung-liang-ki, and also on the reports of Baber traveling through Yunnan (1878,

cited in Wu Liang-te), well-acquainted with plague as a disease of man and rat frequently occurring there.

Based on information he had obtained from Yunnan practicing physicians Savern (1925) reported that: "An ancient curse, most malevolent and widespread among inhabitants of Yunnan, consists in calling to the gods to afflict some physician with the disease yang-tse (ts'u), which is the name for plague in the local dialect." The manuscript on epidemics already cited lists twelve plague-like epidemics in the province of Yunnan beginning from 1165 A. D. Four of these were accompanied in the manuscript by remarks of preceding hunger or drought. No other indications are given as to nature of the epidemics.

Chao Yung-ling (1957), studying manuscripts of Yunnan Province presents a long list of plague-like and clearly plague epidemics occurring here during the last five centuries.

Table 3  
Plague on the Island of Taiwan

Ⓐ Годы	Ⓑ Заболело	Ⓒ Умерло	Ⓓ Летальность в %
1897	730	56	77,5
1898	1233	82	71,5
1899	2637	1985	75,6
1900	1079	809	75,0
1901	4496	3670	81,6
1902	2308	1853	80,3
1903	885	718	80,0
1904	4500	374	75,0
1905	2398	2100	87,5
1906	3272	2609	79,7
1907	2592	2241	86,5
1908	1270	1159	83,4
1909	1026	848	82,6
1946	13	4	—
1947	1	0	—

[Legend:] a) years; b) affected; c)  
succumbed; d) mortality in percent.

Table 4

## Infectivity of Rodents in T'aik'u (Island of Taiwan)

Годы	Обнаружено зараженных		
	черных крыс	серых крыс	домовых мышей
1903	251	12	18
1904	242	19	8
1905	185	57	15
1906	166	26	20
1907	382	106	69

[Legend:] a) years; b) found to be infected; c) black rats; d) gray rats; e) house mice.

In the year 1514, "Major epidemic in Hech'ing and Lichian. Number perishing could not be counted." Major epidemics were noted in 1514 (Yaon), 1557 (Tali), 1608 (Wuting), 1617 (Wuting, 1758 (Chien-Ch'uan), 1779 (Lichien), 1787 (Tengch'uan, Thiach'ing; "the dead numbered 10,000, fields were deserted, neither people nor smoke could be seen in the villages"), 1792 (Mitu, Finyi; described by Shi Tainan, see above), 1793-1804 (Tench'an, Yun-Lung, Langts'ung), 1840 (valley of the Nuchiang River -- reports by the European missionaries Baber and Grosvenor), 1855 (regions of the Hueitsu nationality), 1869 (central and eastern areas of the province), 1866 (Kunming), where according to the reports of missionaries up to half of the population of the city perished, (1871-1873) Hsumao and P'uer, also brought into Kunming, Ch'uching, Changyi, Mienting; as the patients -- neck and submuscular buboes, high temperature; peak of epidemic occurred during the autumn harvests), 1875 (Tenchuan), 1875-1893 ("annual epidemics in the hsien of Tengchuan. The pestilance first began among the rats. Then, among the people. Villages being emptied."); 1838-1876 (several epidemics in K'aihua); 1882-1891 (Major epidemic in Loping; half of the population succumbed."); 1889 (Mentse) (Tz'u), from here into Lungkow, Kwangsi Province, Peihai, Chuich'eng); 1895 (Nanwei); 1894-1900 (major epidemics in different parts of Yunnan); 1908 (Tengchung, Haich'uan); 1920 (Lung-ch'uan, P'ienma); 1923 (Yuanchiang, Langts'ang, Puer).

In 1939, plague was carried, it was assumed, into Yunnan from the country of Shan (Burma) endemic in plague in

connection with the building of the Burma Road. Affecting 119 (96 of whom died), plague was absent during the next three years according to official data. However, Chao Yung-ling reported on plague victims during 1951-1943 in Nanchao, on the border with Burma. In 1944, due to increased movement along the Burma Road plague in Yunnan, beginning from Teng-chung, resulted in 542 cases. Later, a quite appreciable number of victims were reported annually: 1945 -- 48, 1946 -- 628, 1947 -- 712, 1948 -- 168, 1949 -- 899, 1950 -- 864, 1951 -- 942, 1952 -- 285, 1953 -- 138, 1954 -- 30. More recent data is lacking. Fenyuk (1959) reports that there has been no plague in Yunnan since 1955.

Wu Liang-te (1936) believed that plague is not an autochthonous disease in Yunnan, but is carried in from Burma. We attempted to explain the major epidemic of 1894-1900 as the introduction of plague by travelers from Central Asia. Muller (1900) believed that plague in Yunnan was brought in from Tibet. In Burma, the natural plague focus is located in close proximity to the Chinese borders and is essentially a continuation of the Yunnan focus. Plague evidently is brought in from the Burmese focus into Yunnan Province, but not as often. Plague evidently is brought in from the Burmese focus into Yunnan Province, but not as often. Plague epidemics in Yunnan by no means always follow in the plagues in North Burma, and frequently, in contrast, precede them or occur at a time when no plague is recorded in North Burma, or begin in areas removed from the border and roads leading to it. Before the construction of the Burma Road and the start of traffic along it a trip from Burma to China took several weeks, which made the transfer of plague over mountain road fairly involved.

Still less logical is the explanation of the almost annual plague epidemics in Yunnan as the incursion of plague from Tibet. The existence of plague in Tibet is highly probable, but not yet demonstrated. Until recently, communication between Yunnan and Tibet proceeded along caravan mountain roads, across high passes covered by year-long snows. The caravan was en route for about three months and passed from Tibet into Dali once a year. In Dali, the Tibetans sold medicinal herbs and bought tea. For plague to travel this route from Tibet is still more involved than from Burma. The appearance of air travel, in spite of its rapidity, has not led to plague being transferred into Yunnan.

Chao Yu-ling quite logically suggests that natural plague foci exist in Yunnan, which explains the continuing

incidence of this infection in the province. Plague cases among its inhabitants are recorded here the year round, the largest number being noted during August-October. From December to May only sporadic cases are found.

The predominant form of plague is the bubonic (92.6%). Pulmonary secondary plague represents to 0.6%, primary -- 0.5%. Among the victims who have the bubonic form inguinal bubos constitute 45.2%, submuscular 19%, and neck 15.2%.

The following infected rodents have been found in Yunnan foci: yellow-breasted rat (R. flavipectus) -- 3% out of 26,000 examined; this rat is the most numerous in the villages, carries out season migrations to the fields; house mouse (Mus bactrianus) -- 0.4% out of 1737 animals examined; Anderson's rat (R. andersoni) -- 4 specimens out of 195; field rat (R. losea) -- 4 out of 86; gray rat (R. norvegicus) -- 2 out of 24; white toothed shrew (Crocidura sp.) -- 2 out of 203; polycuspid shrew (Suncus murinus) -- 1 out of 262, frequently enters homes; field mouse (Apodemus agrarius chevrieri) 148, frequently enters homes; forest squirrel (Callosciurus erythraeus) -- 1 out of 29, infrequently enters residences.

Spontaneous infection has also been noted in the harvest mouse (Micromys minutus pigmaeus) and voles (Eothenomus sp.). It is believed that the most important plague carrier in Yunnan is the yellow-breasted-rat. Data on the role of marmots and ground squirrels is lacking.

Abe (1940) showed that in Yunnan province are found the potential plague carriers -- Himalayan marmots (Marmota himalayna robusta) and conies (Ochotona tibetana). In addition, more than 10 species and subspecies of rats are found in Yunnan (R. Norvegicus socer, R. rattus islandeni, R. flavipectus yunnanensis, R. nitidus, R. Iosea celsus, R. confucianus, R. fulvescens, R. bowerdsi, Bandicota nemorivaga, etc.), of which the most frequently found in foci are three subspecies of the black rat, gray rat, Anderson's rat, and mice of the genera V. andeleuria -- two species, Leggada -- two subspecies, house mouse (M. bactrianus), field mice (A. agrarius chevrieri, etc.), several species of forest mice (A. peninsulae, A. sylvaticus orestes, A. lafroti), and voles (genus Microtus -- three species, genus Eothenomus -- six species), and also representatives of giant squirrel genera (Ratufa), chipmunks (Tamiopis), forest squirrels (Callosciurus), flying squirrel (Petaurista and Belomys), and bamboo rats (Rhyzomys). The flea X. cheopis is frequently found on rodents (21% of catches) in Yunnan, as well as in all of

China (By, 1940). Here, Leptopsylla segnis is found, also spontaneously plague-infected (Cheng Weng-kuei, Yang Ch'ing-hsiu, and Ku Fan-chow, 1960), representing 73% of catches.

Ceratophyllus (Nosopsylla) nicanus is a flea which is found in both wild and synantropic rodents.

As concerns the provinces of Sikang, Tsinghsia, North-east Szechwan, and the Tibetan Autonomous Region, the view is held that these high-mountainous areas representing a continuation of so-called Himalayan plague focus are one of the most ancient plague areas, from which plague can penetrate into southwest China. Here, we find the Daurskiy suslik (Tsinghai, Tibet), the long-tailed marmot (Tibet), the Himalayan marmot (M. himalayana robusta -- Sikang), gray marmot (Tsinghai), several species of conies (Ochotona tibetana -- Tibet, O. erythrotis -- Tibet, O. roylei chinensis -- Sikang), Tsokor (M. yospalax fontanier baileyi -- Sikang), voles (Microtus, Eothenomys chynensis and E. custos hintoni -- Sikang), prygunchik (Lapus setchucnus -- Sikang).

During 1954-1957, the Chinese Antiplague Institute found a spontaneous carrier condition and active plague epizootias in gray marmots Daurskiye susliks in several hsien of Tsinghai Province (Cheng Weng-huei et al, 1960). Numerical data on the incidence of persons with plague in these areas is not available. This can be explained by the low density of population (Tibet -- 0.8, and Sikang -- 4 persons per square kilometer), the almost total lack of means of communication, and also the nonexistence (until recently) of a system of recording infective diseases.

Ancient Tibetan medicine is well acquainted with the plague (Berlin, 1940), and its classical works include a long series of methods of treating this disease.

Northwest China and the Inner Mongolian Autonomous Region represent most enormous territory, where plague is enzootic, forming a large number of more or less sharply distinct natural foci. Thus, in Sinkiang, in particular in Kashgaria (Burumchan), even Pal'chinskii (1898) established the existence of a plague focus. V. P. Smirnov (1938) also reported on plague in Sinkiang.

Recently, (1954-1957) the Urumchi and Chanchun Anti-plague Institutes detected in the mountains near the city of Manas, in the area of the city of Tsinho (Tingho), and in the hsien of Ucha (Ulugchat, near the boundaries of the

Kirghiz SSR) plague-infected gray and long-tailed marmots and large jerboas, and also their fleas (Oropsylla silantiewi and Callopsylla dolabris).

B. K. Fenyuk (1959) points to the considerable similarity of natural conditions of these localities with the conditions of bordering rayons of the Kazakh and Kirgh SSR's and suggests that the appearance of plague in Sinkiang must be similar to its appearances in Soviet Central Asia.

In the mountainous regions of Sinkiang, cases of human infection with plague developed chiefly during the marmot hunting season (June-August). Chiefly affected are shepherds in mountain pastures, and hunger. Outbreaks in populated places generally arise as the result of plague being carried in by a person infected in mountain pastures. B. K. Fenyuk (1959), extrapolating from observations made in Sinkiang to the Central Asiatic desert focus, believes that plague transfer is possible to inhabited localities by rodents also (in those places where the desert closely approaches the oases). However, thus far plague appearances in persons or rodents has not been detected in the deserts of Sinkiang. Here, plague carriers are found in the gray and long-tailed marmots (Cheng Weing-huei, Yang Ch'ing-hsiu, Ku Fang-chow, 1960). In some regions of this enormous area, suslik (Daurskiye and long-tailed) also participate in preserving plague infection, as was first pointed out even by D. K. Zabolotnyy (1898). Jerboas (Brachionomys sp., Rhombomys opimus, Meriones tamaricinus, M. ungniculagus), tushkanchiki (Dipus cardiorinus, Allactaga sp., Allactagulus sp.), and several other rodents also, can evidently participate in plague epizooties.

Data on plague in Kansu Province is very scanty. An endemic region is known to exist near T'aotung. Yang Ch'ing-hisu (1957), based on landscape-epidemiological and historical assumptions, regards the existence here of natural plague foci as being highly probable.

The reasons behind the absence of major outbreaks of plague in Northwest China are as follows:

a) low density of population in most of the regions enzootic in plague and the nomadic way of life of many of the inhabitants;

b) the practical knowledge of the local inhabitants as to plague epidemiology and the ability to avoid contact with infected rodents;

c) relatively low densities of synantropic mouse-like rodents (mice, rats) capable of serving as an intermediate link in the chain: hibernating rodents -- their fleas -- synantropic mouse-like rodents -- their fleas -- man. The construction of railroads, industrial enterprises, and agricultural assimilation of new lands can occasion plague outbreaks in this area.

In the provinces of Shansi and Shensi population density is lower than in Central, South, and East China, but very much higher than in Western China (Shansi -- 74, Shensi -- 52 persons per square kilometer). Accordingly, due to the existence of local foci, plague epidemics have quite recently been widely extended here, involving tens of thousands of persons.

Epidemics ("i-cheng") in the provinces of Shansi and Shensi are quite common in the list of plague and plague-like epidemics given in the Imperial Encyclopedia (1726). From 641 A.D. to 1644, the manuscript notes that 30 major plague-like epidemics have occurred in Shansi province: 641, 642, 643, 644, 648, and 1352 A.S. (900,000 persons succumbed); 1353, 1358 (200,000 persons died); 1414, 1504 ("in this year China was almost completely decimated by the plague"); 1528 ("Many districts have become depopulated"); 1543, 1544, 1560 ("Nine out of ten houses have been emptied"); 1570, 1588, 1582, 1585 ("Mortality was so high that even relatives could not conduct the funeral rites"); 1588 ("Whole families perished, in other districts no one was left to harvest the wheat"); 1610, 1611, 1612, 1618, 1633, 1635, 1641, 1643 and 1644. "Great Pestilence" in 1644 in the city of Lu-an (Shansi), judging from the description in the manuscript cited above, evidenced the characteristic signs of bubonic plague.

Wu Liang-te, Pollitzer, Ling Chia-sui and Jettmar (1929) described two hsien endemic in plague (Hsin Hsien and Mino Hsien) in the western part of Shansi Province, pointing to their isolation from the rest of the country, mountainous relief, inadequate transportation routes, infrequent population. In the Hsin Hsien plague outbreaks were recorded in 1912, 1915, 1916, 1917, 1918, 1919, 1921, 1922, 1923, 1924, 1925, 1926, 1927, and 1928. The bubonic form predominated. Cases occurred in different villages, frequently at a considerable distance from the Yellow River [Hwangho] and the caravan route from Mongolia to Pao-tow. This locality is where the major epidemic of 1928 began.

Min Hsien is as mountainous as Hain Hsien. It includes 1200 small villages, with three-four families in each. Plague

appeared as a rule during autumn in 1917, 1918, 1919, 1920, 1921, 1922, 1923, 1924, 1925, 1926, 1927 and 1928. Here, the most common rodent is the suslik (Watson, 1928). During the 1919 outbreak there was a larger plague of rats.

The 1928 outbreak, resulting in more than 1000 deaths, according to very approximate estimates, began in the Hsin Hsien, spread to Min Hsien and Chikou Hsien, and then enveloped five hsien of Shensi Province, lying on the western shore of the Hwangho, and penetrated into the city of Paotow and Hun-yuan Hsien (320 kilometers northeast of Minhsiang). The pulmonary form represented no more than 10%, a plague of rats was observed.

Wu Liang-te (1920) believed that plague is carried into the provinces of Shansi and Shensi from the country of Ordos (Inner Mongolian Autonomous Region), where it is endemic, in his view. He argues for the latter by relating that the local Mongolian population is well acquainted with the clinical aspects and epidemiology of plague and has developed a system of primitive, but reliable antiepidemiological measures (departure from infested locality, for bidding contact with sick rodents and persons, etc.).

In the densely populated hsien of Shansi and Shensi Provinces, the centuries-long intensive farming of the locality has led to a sizable reduction in the density of susliks and other wild rodents, and in places to their complete extermination. Natural plague foci can be perpetuated only in underpopulated regions, with a high percentage of unfarmed land, where there are appreciable populations of wild rodents, especially Daurskiye susliks (Mongolian and Alashan'-skiye subspecies).

The best-studied and most active plague focus in Northeast China is the so-called West Manchurian focus, reported on most reliably by V. M. Popugaylo (1959). This focus, dependent for its existence chiefly on Daurskiye sisliks and to a lesser extent tarbagany and Mongolian jerboas, extends over the southern and central portion of Inner Mongolia, and is interrupted only here and there by low spurs of the southern portion of the Hsingkang Mountains, and encompasses the western boundaries of the provinces of Kirin, Jehol, and Heilungkiang of Northeast China, and the northwest of Hopei Province in East China.

Numerous acutely progressing plague epizootias in Daurskiye susliks have appeared annually in these regions

(chiefly in the Inner Mongolian Autonomous Region). The epizootias can include hamsters (rat-like and barabinskiys), Daurskaya cony, and house rodents. As far as fleas are concerned, here we find infected *H. cheopis*, *Ceratophyllus tes-quoram sungaricus*, *Frontopsylla luculenta*, *Neopsylla bidentiformis*. Also isolated have been plague bacillus cultures from *Ixodes* ticks (species not determined).

Since the time of the last war-related epidemic of plague in 1947, when more than 30,000 cases were recorded in the territory of the former Manchuria, according to very incomplete data (including a sizable percentage of the pulmonary form), plague has here become sharply decreased, but thus far continues to be found in a number of cases annually.

The most enzootic steppe and desert-steppe regions of this focus are underpopulated, and the land is used chiefly for pasturing. Due to the nomadic way of life, the population and its limited contact with steppe rodents plague here is infrequent in individuals.

In the areas where territory has been farmed, railroads and mines constructed, and permanent inhabited locations exist, human infection with plague infrequently occurs as the result of contact with steppe rodents and their ectoparasites during farming work, but more often as the result of house rodents (gray rats, house mouse) becoming incorporated into the epizootia chain. In summer, up to 20% of rat fleas *X. cheopis* are found on *Darusskiye susliks*, and on rats -- fleas of *susliks*, jerboas, etc. (Kasuga, 1943). During autumn, rats bear fleas and plague into human residences, which serve as an intermediate link, without which major plague epidemics would be impossible.

However, to regard this plague as dihostal (Kamnev, 1958), is valid only as the result of a quite peculiar understanding of the term, radically departing from the commonly accepted meaning. *Darusskiye suslik* here is the principal and permanent plague bacillus host. Where this animal is not to be found, even very numerous rat populations do not meet any prolonged existence of plague infection. Cheng Wen-huei, Yang Ch'ing-hsu, and Kufang-chou (1960) quite properly regard rats in the foci of the Northeast as only temporary plague-carriers.

## Conclusions

Study of Chinese manuscripts and classic works of Chinese medicine has shown that plague as a pestilential disease has been known in China since antiquity. During the intensive development of trade routes by means of sailing (wooden fleets, and also unsanitarily maintained steam fleets) numerous cases of ship-borne infected rats from plague foci of the southern seas occurred, leading to outbreaks and epidemics of port plague. Progress in ship-building, and also in the system of rat extermination and quarantine measures sharply remedied the situation. At present, the entry of plagues by sea is extremely rare (only 2% of ocean-going ships are infested with rats). As a result, port plague in China during the last several decades has essentially disappeared. This permits a better understanding of the structure of foci which have retained their activity until recent times.

Plague foci in China can be divided into northern and southern. The first group includes foci in Northeastern China, the Inner Mongolian Autonomous Region, the provinces of Tsinghai, Sinkiang Uighur Autonomous Region, and in the recent past includes also foci of the provinces of Jehol, Shansi, Shensi, Kiangsu. In addition to foci of the Mongolian People's Republic, this focal group constitutes the Central Asiatic plague ("autonomous") focus. Plague here is of the clearly pronounced natural-focal variety and is related to hibernating rodents (marmots and susliks) as the principal and permanent carriers of the causative agents of this infection. The role of jerboas as plague carriers in several areas of this territory is highly probable, but not yet demonstrated. Strains of plague bacillus isolated here, as a rule, decompose glycerine.

The second group includes foci of the south and southwest of the country, located in the provinces of Fukien, Yunnan, Kwangtung, on the Island of Hainan, and in the recent past also in the provinces of Szechwan and Kwangsi. Problems of plague epizootiology here have been little studied, although these foci (especially in Yunnan province) and on the Island of Hainan) must be regarded as among the natural-focal as to several features. It is possible that several of the southern foci belong to the category of temporary (ephemeral).

Based on data accumulated thusfar, the principal plague carrier here must be regarded as various species of

the black rat. The role of marmots, ground and forest squirrels, and polycuspid shrews is in need of more detailed study. Strains of the plague causative agent isolated in the southern group of foci do not, as a rule, decompose glycerine.

The Autonomous Region of Tibet, together with Sikang Province, is also regarded in the literature as a plague territory from which plague can be carried into other areas. However, data on the epizootiology and epidemiology of plague in this area is lacking.

Natural plague foci still extend over enormous expanses in China, and their potential threat is as great as ever. Farming of new land and construction of railroad, especially in the northwest and northeast of the country can result in contact of persons with enzootic foci, previously unknown because of the low population density and the lack of recording of infectious cases.

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